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Work Assignment				<input type="checkbox"/> Other <input type="checkbox"/> Amendment Number						
Contract Number <div style="font-size: 1.2em; font-weight: bold;">EP-C-09-027</div>		Contract Period <div style="font-size: 1.2em; font-weight: bold;">4/1/09 - 3/31/10</div>		Title of Work Assignment/SF Site Name Biomass Burning & Biogenic PM Meas						
Contractor		Specify Section and Paragraph of Contract SOW 1.6. 5.1								
Purpose <input checked="" type="checkbox"/> Work Assignment <input type="checkbox"/> Work Assignment Amendment <input type="checkbox"/> Work Plan Approval		<input type="checkbox"/> Work Assignment Close-Out <input type="checkbox"/> Incremental Funding		Period of Performance From <div style="font-size: 1.2em; font-weight: bold;">4/6/09</div> To <div style="font-size: 1.2em; font-weight: bold;">3/31/10</div>						
Comments: CWS# 418 Continuation of EPA 4-2 under contract # EP-C-04-023										
<input type="checkbox"/> Superfund Accounting and Appropriations Data <input type="checkbox"/> Non-Superfund										
Note: To report additional accounting and appropriations data use EPA Form 1900-69A.										
SFO (Max 2) <div style="font-size: 1.2em; font-weight: bold;">22</div>										
Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code (Max 7)
1										
2										
3										
4										
5										
Authorized Work Assignment Ceiling										
Contract Period		Cost/Fee		LOE:		0				
						1521				
						1521				
Total										
Work Plan / Cost Estimate Approvals										
Contractor WP Dated:		Cost/Fee:		LOE:						
Cumulative Approved:		Cost/Fee:		LOE:						
Work Assignment Manager Name <div style="font-weight: bold;">CN=Chris Geron/OU=RTP/O=USEPA/C=US</div> <div style="text-align: right; font-weight: bold;">03/26/2009</div> <div style="text-align: center; font-size: 0.8em;">(Signature) (Date)</div>						Branch/Mail Code: Phone Number: <div style="font-weight: bold;">919-541-4639</div> FAX Number:				
Project Officer Name <div style="font-weight: bold;">Diane L Pierce</div> <div style="text-align: right; font-weight: bold;">4/1/09</div> <div style="text-align: center; font-size: 0.8em;">(Signature) (Date)</div>						Branch/Mail Code: Phone Number: <div style="font-weight: bold;">919-541-2708</div> FAX Number: <div style="font-weight: bold;">919-541-1536</div>				
Other Agency Official Name <div style="font-weight: bold;">C. Andrew Miller</div> <div style="text-align: right; font-weight: bold;">4/1/09</div> <div style="text-align: center; font-size: 0.8em;">(Signature) (Date)</div>						Branch/Mail Code: Phone Number: FAX Number:				
Contracting Official Name <div style="font-weight: bold;">Remita Tyus</div> <div style="text-align: right; font-weight: bold;">4/6/09</div> <div style="text-align: center; font-size: 0.8em;">(Signature) (Date)</div>						Branch/Mail Code: <div style="font-weight: bold;">CPAD</div> Phone Number: <div style="font-weight: bold;">513-487-2094</div> FAX Number: <div style="font-weight: bold;">513-487-2109</div>				

SCOPE OF WORK

BACKGROUND

The APPCD natural emissions sources team has been funded to perform emission characterization and chemical profile analysis of major particle and trace gas emission sources. The focus of the following tasks will be to further develop and implement field sampling techniques to capture particle and trace gas samples from biomass open burning, natural biogenic processes, and agricultural activities. We will examine trace gas and particle concentrations and composition above biomass fires, forest canopies and agricultural areas to better understand these source contributions to ambient PM concentrations. This may include development of portable and remotely controlled sampling platforms capable of drawing large volumes of smoke from *in situ* fires and ambient air above forests. We will specifically target forested ecosystems in North Carolina, including forested eastern peatlands, mixed hardwood/pine forests and longleaf pine/wiregrass.

This Work Assignment will provide field measurement methods development and database management support to characterize CO₂, CO, CH₄, volatile organic compounds (VOC), and PM so that emissions from important forest fuel components will be characterized. This will also allow mass balance calculations to be performed so that fluxes of co-sampled trace gases (including dioxins, CH₃Br, CH₃Cl, and possibly Hg) may be determined by other APPCD collaborators. This Work Assignment will also provide technical support for N₂O, NH₃, NH₄⁺, biogenic aerosol, and biogenic organic trace gas sampling.

It is generally thought that emission factors or pollutants are among the more consistent and reliable components of biomass burning emission models. However, comparisons of recent studies suggest that under some conditions, especially where smoldering combustion is important, emission factors (EF) are still quite uncertain (Andreae and Merlet, 2001 in Global Biogeochemical Cycles; Hays et al., 2002). Residual smoldering combustion (RSC) emissions in deep organic soils can persist for weeks to months. Limited observations suggest that RSC is a globally significant source of emissions to the troposphere (Bertschi et al., 2003 in Journal of Geophysical Research). These authors used a model which predicts trace gas EF for fires in a wide variety of aboveground fine fuels. It failed to predict emission factors for RSC. For many compounds, the EF for RSC-prone fuels is very different from the EF for the same compounds measured in fire convection columns above forest ecosystems. Some large changes resulted in estimates of biomass fire emissions with the inclusion of RSC. For instance, EF increases by a factor of 2.5 even when RSC accounts for only 10% of fuel consumption. This shows that many more measurements of fuel consumption and emission factors for RSC are needed to improve estimates of biomass burning emissions. This is especially true for fire in organic soils on the southeastern US coastal plain.

Recent CMAQ analyses have also highlighted the need for improved seasonal biogenic volatile organic compounds (BVOC) emission estimates. These ozone and SOA precursors include, but

are not limited to, isoprene, monoterpenes, sesquiterpenes, and oxygenated BVOC. We will conduct field studies to address these issues as well.

Task 1

Recent particulate matter (PM) and gas phase chemistry (as well as PM physical characteristics) have been described in Hays et al. 2002 (*Environmental Science and Technology*). These studies were conducted in controlled environments; however, and there is a need to test PM_{2.5} EFs and tracer ratios derived in these studies with data from actual fires in the field.

APPCD received funding from the U.S. Department of Interior Fish & Wildlife Service through the Joint Fire Sciences Research Program to conduct research related to these tasks. More detail is given in the proposals: ***“Development and Demonstration of Smoke Plume, Fire Emissions, and Pre- and Post Prescribed Fire Fuel Models on North Carolina coastal Plain forest Ecosystems”*** and ***“Predicting Prescribed and Wildland Fire Smoke, Emissions, and Fire Characteristics in Deep Organic Soils”***. The contractor has copies of the research plans summarized within these proposals. The contractor shall follow the guidelines within the proposals to design remote controlled continuous sampling systems.

The objective of the proposal is to develop, calibrate, and deploy methods to provide sample materials from actual fires similar to those provided by the controlled studies of Hays et al., (2002). The Contractor shall evaluate remote sampling platforms such as remote controlled helicopters and small unmanned blimps for application to this testing need. The Contractor shall consider smoke plume age, particle filter loads, trace gas collection, sample package weight, payload, and cost in developing these systems. Initial plans must be submitted to the WACOR for review. Sample criteria are further described in tasks 2 and 3 below.

Test prescribed fires will take place in the NC coastal plain and piedmont during 2009 and 2010. The contractor shall monitor emissions using an unmanned sampling system from a fire on coastal plain peatland forests. The Contractor shall characterize continuous measurements of photochemically active and radiatively important trace gases as well as PM emissions from this prescribed burn. At a minimum, continuous estimates of CH₄, total NMHC, CO, CO₂, and PM_{2.5} are needed. The contractor shall also evaluate the possibility of implementing continuous FTIR for organic trace gas measurements. The CO measurements from small sulfuric acid reaction detectors currently used in our portable smoke sampling packages can be relatively slow to respond to rapid changes in concentrations, so the effects of this lag should be determined by comparison with gas filter correlation methods in the metrology lab.

The Contractor shall quantitatively analyze these samples to determine emission factors for individual trace gases. These should be compared with factors from other fuel types. The Contractor shall compare current source apportionment chemical fingerprints from these fires with those from our laboratory and “burnhut” studies (Hayes et al., 2002). This will allow us to

assess these signatures with *in situ* data. The Contractor shall also compare emission factors and fluxes with any available data from wildfire emissions from corresponding forest types.

The Contractor shall calculate emission fluxes from the concentration data using mass balance techniques. The WACOR will also be conducting trace gas and PM_{2.5} measurements using a separate and independent lightweight portable system for comparison.

Deliverables: Within 3 months following each burn, the Contractor shall deliver to the WACOR a report (in MS Word format) and database (in Excel format) of the continuous particle and trace gas measurements from the test fire.

Task 2

If it is determined by the WACOR that additional test burn (controlled environment, "burn-hut" experiments) data are needed, the Contractor shall conduct controlled burning emission sampling using the facilities described above. It may be necessary to acquire additional eastern NC fuels such as peat soil or marsh grass residues commonly burned in wildfires or Rx burns. These shall be acquired by the Contractor and tested (at least two replicate samples of each) if need is determined by the WACOR. **Small samples (approximately 20-40 grams) shall be weighed, oven dried (at 80 to 90EC) for 48 hours to constant moisture content, and re-weighed by biomass component (e.g. decomposed organic matter, humus, stems/leaves/twigs, other) to gravimetrically determine moisture content prior to burning.** Emissions of CO₂, CO, CH₄, PM_{2.5}, PM₁₀, and VOC will be collected by the Contractor in collaboration with APPCD staff using the dilution sampler (if needed) as prepared by the APPCD Emissions Characterization and Prevention Branch. Biomass sample size, fuel moisture/array, and burn time shall be planned such that PM filter samples will contain a minimum of 1 mg of material needed for PM chemical characterization by APPCD. Thus far, sample size (for each individual test burn) needed to ensure adequate PM sample mass is approximately 12 kg @ ~14% moisture content. Furthermore, individual emissions samples should be collected during both flaming and smoldering stage of each fuel bed type. Continuous monitoring of CO₂ and CO will provide useful information on flaming and smoldering phases during the course of the burns.

Fine PM samples will be collected on 37 mm diameter quartz filters, which will be supplied and analyzed by APPCD staff for fine particle composition. These filters are to be handled by forceps in order to avoid contamination. The test data will be delivered to the WACOR for analysis. Complete details for handling the PM samples are found in the memo regarding "**PM-2.5 samples for source apportionment**" dated March 9, 1999. This information has been supplied to the Contractor.

Deliverables: Within 2 months following each burn, the Contractor shall deliver to the WACOR a report (in MS Word Perfect format) and database (in Excel format) summarizing particle and trace gas emission fluxes from each phase of each fire. The atmospheric conditions during each burn shall be reported in addition to fuel consumption, fuel moisture, and a description of the fuel

of the CO₂ gas generated during graphite production with either a VG PRISM or VG OPTIMA mass spectrometer. However, some carbonate samples are reacted and measured directly with the VG PRISM ISOCARB. The $\delta^{13}\text{C}$ value used to calculate the Fm of a sample is specified in the report of Final Results.

Reporting of ages and/or activities follows the convention outlined by Stuiver and Polach (1977) and Stuiver (1980). Radiocarbon ages are calculated using 5568 (yrs) as the half-life of radiocarbon and are reported without reservoir corrections or calibration to calendar years. For all sea water samples, where collection date is known, a $\Delta^{14}\text{C}$ activity which has been corrected to 1950 values is also reported. For other samples where $\Delta^{14}\text{C}$ is reported, we assume the collection and measurement date are the same and leave it to the submitter to make further age corrections. Atoms of ^{14}C contained in a sample are directly counted using the AMS method of radiocarbon analysis; therefore, internal statistical errors are calculated using the number of counts measured from each target. An external error is calculated from the reproducibility of individual analyses for a given target. The error reported is the larger of the internal or external errors. When reporting AMS results of samples run at the NOSAMS facility, accession numbers (e.g. OS-####'s) are required to be listed together with the results. To avoid confusion, we suggest tabulating OS-numbers and associated radiocarbon ages as they appear on the attached Final Report in addition to any subsequent corrections that may need to be made to the ages. We ask that published results acknowledge support from NSF by including the NSF Cooperative Agreement number, OCE-9807266. The NOSAMS facility would appreciate receiving reprints or preprints of papers referencing AMS analyses made at the NOSAMS facility. Any sample material not consumed during sample preparation or AMS radiocarbon analysis is archived for two years at the NOSAMS Facility unless other arrangements are made by the submitter.

REFERENCES

- Karlen, I., Olsson, I.U., Kallburg, P. and Kilici, S., 1968. Absolute determination of the activity of two ^{14}C dating standards. *Arkiv Geofysik*, 4:465-471.
- Olsson, I.U., 1970. The use of Oxalic acid as a Standard. In I.U. Olsson, ed., *Radiocarbon Variations and Absolute Chronology*, Nobel Symposium, 12th Proc., John Wiley & Sons, New York, p. 17.
- Stuiver, M. and Polach, H.A., 1977. Discussion: Reporting of ^{14}C data. *Radiocarbon*, 19:355-363.
- Stuiver, M., 1980. Workshop on ^{14}C data reporting. *Radiocarbon*, 22:964-966.

Deliverables: The Contractor shall provide instrument output files (in MS Excel or ASCII format) on a monthly basis for those CEMS deployed at the field sites, including (but not limited to) the Aethalometer, condensation particle counter, and CO, NO_x, SO₂, and O₃ monitors. The ^{14}C estimates for the filter analyses should provide uncertainty estimates and mean percent modern carbon in Excel format. The NOSAMS format is recommended and we include samples from

array prior to burning.

Task 3.

This task supports ambient and Teflon bag enclosure measurements of C_2 - C_{16} BVOC. The Contractor shall assist in the application of an existing SRI GC/FID system to allow sampling directly from ambient air or vegetation enclosures. The SRI GC system is currently located in Lab D475 where it has been modified by the WACOR. It will be moved to Lab E584 where it can be used to analyze plant emission samples from a Conviron environmentally controlled growth chamber. It is a dual channel system with a two stage preconcentration unit consisting of parallel $\frac{1}{4}$ " traps packed with carboxen and carbopack B followed by $\frac{1}{8}$ " traps with Carboxen, Carbopack B and Tenax TA. Dual metal MXT 30 m columns are followed by FID detectors. The system should be calibrated for a list of biogenic VOC to be provided by the WACOR. The GC will be used to determine concentrations in ambient samples collected for the purpose of determining ambient VOC concentrations and emissions from vegetation. In addition to the necessary hardware modifications, the Contractor shall develop suitable injection and calibration methods. Descriptions of the system are attached.

A portable GC/MS has also been acquired by the WACOR for use on this task. It consists of a Inficon ER unit which has a Rtx-1MS column (100% polydimethylsiloxane, $1\mu m$ df, 15 meter length, 0.25 mm i.d.) in a temperature programmable oven (to 200°C). Preconcentration is performed by drawing sample at 100 ml min^{-1} through a tri-bed trap consisting of Carbopack Y, Carbopack X, and Carboxen 1018. A single bed preconcentrator packed with Tenax TA is also available. The WACOR is currently calibrating this system for BTX, BVOC and other compounds commonly found in biomass smoke. It will also be used to identify other compounds not currently in our databases.

The filters are held in place by a quartz tube through which the ambient air is passed. Upon completion of the collection period (typically 167 min.), air is purged from the system and the filter is heated in an Ultra High Purity (UHP, >99.9995%) He atmosphere to 650°C and held for ~ 0.5 min, then heated to 850°C, held for 1 min to complete the thermal step for releasing OC. The oven containing the filters is then cooled to 650°C, and the carrier gas is then switched to 10% O₂ in He. The oven temperature is again increased to 850°C to oxidize and volatilize EC and residual char formed during heating of the OC in the previous steps. As the oven cools, an external calibration is performed by injecting 1 ml of 5% CH₄ in He. At 760 tor and 298°K, this standard injection contains 24.54 µg of carbon. The carbon from the external standard or that volatilized from the filter is converted into CO₂ as it passes through a MnO₂ catalyst. The CO₂ is then quantified by a non-dispersive infrared (IR) detector (RMT Ltd., Moscow, Russia). The split between OC and EC is determined by laser correction. A tuned diode red laser beam (660 nm) is passed through the filter during sampling and analysis. After sample collection and prior to the initial temperature increase, laser absorbance is recorded. Charring of OC on the filter can increase absorbance during the initial temperature increase in the He environment. During the second heating stage in the He/O₂ stream, elemental carbon is oxidized off of the filter and red light absorbance decreases. When absorbance decreases to its initial value, the "split point" is reached, and carbon that evolves after this split point is classified as elemental. Peaks integrated prior to the split point are classified as OC. This process is illustrated in a typical thermogram below.

During the sample collection period, the front oven containing the sample filters is typically 10-20°C above ambient temperature. No correction is applied to account for possible loss (if any) of SVOC from the filter due to this heating. The thermogram in Figure 1 below suggests that this loss is likely to be negligible, since little carbon evolved from the filters at temperatures below 100°C.

The contractor may be required to upgrade the chassis of the Sunset OC/EC analyzer to incorporate a variable speed, high volume cooling system and a new NDIR detector. These upgrades will improve sensitivity and tolerance to hot summertime ambient conditions.

samples used in IOGAPS PM_{2.5} samples. Methods are discussed in detail in Fan et al (2003, ES&T 37:14 pp 3145-3151).

The TSI condensation particle counter will also be deployed at Ring 5. The Contractor shall provide instrument calibration data for the CFMs to the WACOR as well.

The WACOR will submit approximately 2 samples per month (plus blanks) to the Contractor for ¹⁴C analysis. The radiocarbon content will be used to estimate the relative amounts of fossil fuel and non fossil fuel related carbon in the atmospheric aerosol samples. The samples will consist of 90 mm circular quartz fiber filters from a high-volume sampler located at Ring 6. These measurements will be conducted by the WACOR. The Contractor shall perform radiocarbon (¹⁴C) analyses using the methods described below.

Filter Handling:

Using a clean pair of metal tweezers, remove any obvious extraneous objects that are clearly not PM-2.5 particles, (e.g., insect parts) from the filters. For all 90-mm dia filters, using a 75.7-mm diameter punch, punch out the interior aerosol deposit area of each filter, and discard the outer ring. Return filters to their Petri containers, seal with teflon tape, wrap with 2 layers of clean Al foil, and place together in a zip-lok bag.

The Contractor shall follow the General Statement of ¹⁴C Procedures used at the National Ocean Sciences Accelerator Mass Spectrometer (NOSAMS) Facility. All laboratory preparations for AMS radiocarbon analyses of submitted samples occur in the NOSAMS Sample Preparation Lab unless otherwise noted on the attached report of Final Results. Procedures appropriate to the raw material being analyzed include: acid hydrolysis (HY), combustion (OC), or stripping of CO₂ gas from water (WS) samples. Carbon dioxide, whether submitted directly (GS) or generated at the NOSAMS Facility, is reacted with catalyst to form graphite. An Fe/H₂ catalytic-reduction is used for all except very small samples, where a Co/H₂ catalytic-reduction is used. Graphite is pressed into targets, which are analyzed on the accelerator along with standards and process blanks. Two primary standards are used during all ¹⁴C measurements: NBS Oxalic Acid I (NIST-SRM-4990) and Oxalic Acid II (NIST-SRM-4990C). The ¹⁴C activity ratio of Oxalic Acid II ($\delta^{13}\text{C} = -17.3$ per mil) to Oxalic Acid I ($\delta^{13}\text{C} = -19.0$ per mil) is taken to be 1.293. Every group of samples processed includes an appropriate blank, which is analyzed concurrently with the group. Process blank materials include IAEA C-1 Carrara marble for inorganic carbon and gas samples; a Johnson-Mathey 99.9999% graphite powder for organic carbon samples; and a commercial tank of ¹⁴C - free CO₂ for seawater samples. Fraction Modern (Fm) is a measurement of the deviation of the ¹⁴C /C ratio of a sample from "modern." Modern is defined as 95% of the radiocarbon concentration (in AD 1950) of NBS Oxalic Acid I normalized to $\delta^{13}\text{CVPDB} = -19$ per mil (Olsson, 1970). AMS results are calculated using the internationally accepted modern value of $1.176 \pm 0.010 \times 10^{-12}$ (Karlen, et. al., 1968) and a final ¹³C correction is made to normalize the sample Fm to a $\delta^{13}\text{CVPDB}$ value of -25 per mil. Stable isotope measurements of sample $\delta^{13}\text{C}$ used to correct Fm values are typically made at the NOSAMS Facility by analyzing sub-samples

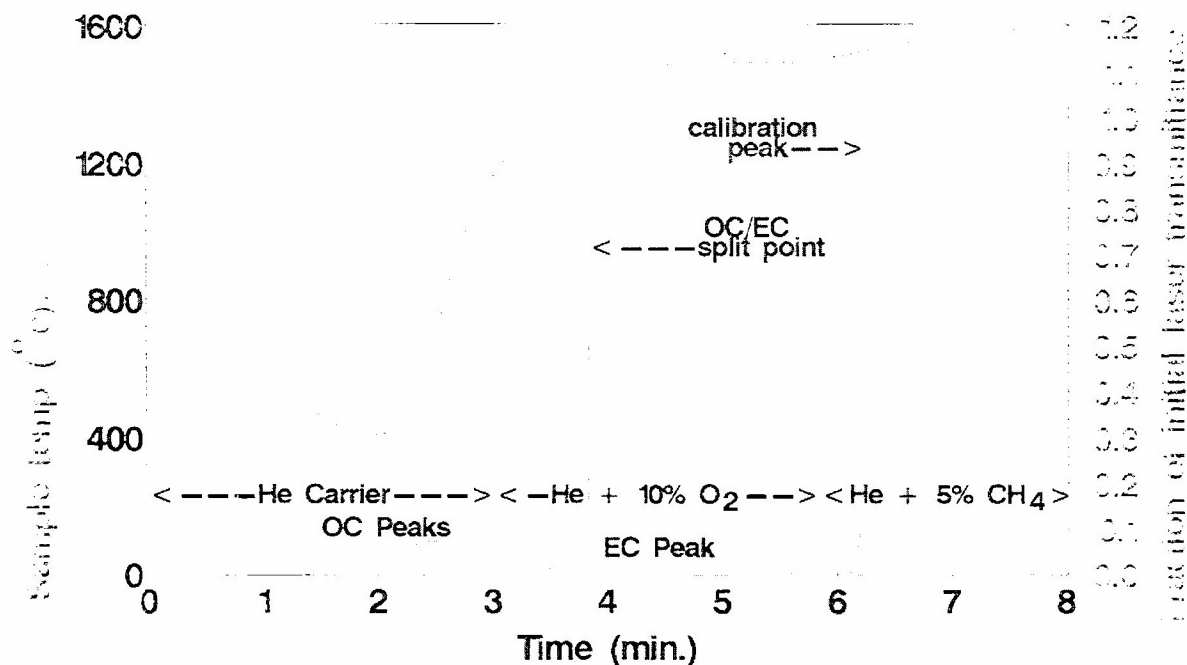


Figure 1. OC/EC Thermogram.

REFERENCES

Geron, C. (2009) "Carbonaceous aerosol over a Pinus taeda forest in central North Carolina." *Atmospheric Environment* **43**:959-969.

Deliverables: After each month of data collection, the Contractor shall deliver to the WACOR a report (in tab-delimited ASCII format) and database (in MS Excel format) summarizing the OC (organic carbon), EC (elemental carbon) CC (carbonate carbon), and TC (Total carbon) in the aerosol collected at the top of Ring 6. Instrument down-time, maintenance schedule, and sample collection period shall be reported in addition to sample volumes.

Task 5.

An Integrated Organic Gas and Particle Sampler (IOGAPS) will be operated and maintained by the WACOR at the top of Ring 6. The WACOR will submit quartz filters from this system to the Contractor. The Contractor shall analyze these periodic filter samples for EC/OC/CC/TC (using Sunset Laboratories Instrument in EPA Lab E580A) content using the methods of Hays et al. (2002). Remainder of filter material shall be stored at sub-freezing temperature (-40°C) for later isotopic analysis and/or chemical tracer analysis as specified by the WACOR for individual filters. The Contractor shall perform GC/MS and total carbon analyses of 2-4 backup PUF



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v_results_0426.xls gov_results_1122.xls

previous sample collections and analyses.

Task 6.

The contractor shall revise the Quality Assurance Project Plan entitled "Quality Assurance Project Plan for Prescribed Fire Emissions Measurements", Revision 2 (or date), to include the activities described in Tasks 1-5. The WACOR has reviewed this plan and found it to be suitable for this proposed Work Assignment. The contractor shall adhere to the QA requirements as delineated in Attachment #1 to the Statement of Work. Work shall not commence until the quality assurance documentation has received official approval from the EPA Quality Assurance Staff.

ATTACHMENT #1 TO THE STATEMENT OF WORK

NRMRL QA Requirements and Definitions

In accordance with EPA Order 5360.1 A2, conformance to ANSI/ASQC E4 must be demonstrated by submitting the quality documentation described herein. All quality documentation shall be submitted to the Government for review. The Government will review and return the quality documentation, with comments, and indicate approval or disapproval. If the quality documentation is not approved, it must be revised to address all comments and shall be resubmitted to the Government for approval. Work involving environmental data collection, generation, use, or reporting shall not commence until the Government has approved the quality documentation. The QAPP shall be submitted to the Government at least thirty (30) days prior to the beginning of any environmental data gathering or generation activity in order to allow sufficient time for review and revisions to be completed. After the Government has approved the quality documentation, the Contractor shall also implement it as written and approved by the Government.

Definitions:

Environmental Data - These are any measurements or information that describe environmental processes, location, or conditions; ecological or health effects and consequences; or the performance of environmental technology. For EPA, environmental data include information collected directly from measurements, produced from software and models, and compiled from other sources such as data bases or the literature.

Quality Assurance (QA) - Quality assurance is a system of management activities to ensure that a process, item, or service is of the type and quality needed by the customer. It deals with setting policy and running an administrative system of management controls

that cover planning, implementation, and review of data collection activities and the use of data in decision making. Quality assurance is just one part of a quality system.

Quality Assurance Project Plan (QAPP) - A QAPP is a document that describes the necessary quality assurance, quality control, and other technical activities that must be implemented to ensure that the results of the work performed will satisfy the stated performance criteria. A QAPP documents project-specific information.

Quality Control (QC) - Quality control is a technical function that includes all the scientific precautions, such as calibrations and duplications, that are needed to acquire data of known and adequate quality.

Quality Management Plan (QMP) - A QMP is a document that describes an organization's/program's quality system in terms of the organizational structure, policy and procedures, functional responsibilities of management and staff, lines of authority, and required interfaces for those planning, implementing, documenting, and assessing all activities conducted. A QMP documents the overall organization/program, and is primarily applicable to multi-year, multi-project efforts. An organization's/program's QMP shall address all elements listed in the "Requirements for Quality Management Plans" in Appendix B of the NRMRI. QMP.

Quality System - A quality system is the means by which an organization manages its quality aspects in a systematic, organized manner and provides a framework for planning, implementing, and assessing work performed by an organization and for carrying out required quality assurance and quality control activities.

R-2 - EPA Requirements for Quality Management Plans (EPA/240/B-01/002) March, 2001, <http://www.epa.gov/quality/qmplans/240b01002.pdf>

R-5 - EPA Requirements for QA Project Plans (EPA/240/B-01/003) March, 2001
<http://www.epa.gov/quality/qaprojplans/240b01003.pdf>

Substantive Change - Substantive change is any change in an activity that may alter the quality of data being used, generated, or gathered.

EPA's Quality System Website: <http://www.epa.gov/quality>

EPA's Requirements and Guidance Documents: http://www.epa.gov/quality/qm_docs.html

Q NRMRI's Quality System Specifications:

(1) a description of the organization's Quality System (QS) and information regarding how this QS is documented, communicated and implemented;

- (2) an organizational chart showing the position of the QA function;
- (3) delineation of the authority and responsibilities of the QA function;
- (4) the background and experience of the QA personnel who will be assigned to the project; and
- (5) the organization's general approach for accomplishing the QA specifications in the SOW.

Category Level Designations (determines the level of QA required):

- Q **Category I Project** - applicable to studies performed to generate data used for enforcement activities, litigation, or research project involving human subjects. The QAPP shall address all elements listed in R-5.
- Q **Category II Project** - applicable to studies performed to generate data used in support of the development of environmental regulations or standards. The QAPP shall address all elements listed in R-5.
- Q **Category III Project** - applicable to projects involving applied research or technology evaluations. The QAPP shall address the applicable sections of R-5, as outlined in the NRMRL QAPP requirements for the specific project type (see below).
- X **Category IV Project** - applicable to projects involving basic research or preliminary data gathering activities. The QAPP shall address the applicable sections of R-5, as outlined in the NRMRL QAPP requirements for the specific project type (see below).

Guidance for QAPPs by Project Type (described in more detail on subsequent pages):

These outlines of NRMRL QAPP Requirements for various project types, from Appendix B of the NRMRL QMP, are condensed from typically applicable sections of R-5 (EPA Requirements for QA Project Plans) and are intended to serve as a starting point when preparing a QAPP. These lists and their format may not fit every research scenario, and QAPPs must conform to applicable sections of R-5 in a way that fully describes the research plan and appropriate QA and QC measures to ensure that the data are of adequate quality and quantity to fit their intended purpose.

- Q **Applied Research Project** - pertains to a study performed to generate data to demonstrate the performance of accepted processes or technologies under defined conditions. These studies are often pilot- or field-scale. Additional guidance is given in "QAPP Requirements for Applied Research Projects".
- X **Basic Research Project** - pertains to a study performed to generate data used to evaluate

unproven theories, processes, or technologies. These studies are often bench-scale. Additional guidance is given in "QAPP Requirements for Basic Research Projects".

- Q **Design, Construction, and/or Operation of Environmental Technology Project** - pertains to environmental technology designed, constructed and/or operated by and/or for EPA. The QAPP shall address requirements in Part C of "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology," ANSI/ASQC E4-1994, American Society for Quality Control, Milwaukee, WI, January 1995. EPA "Guidance on Quality Assurance for Environmental Technology Design, Construction and Operation (QA/G-11)" is in the final stages of development. The final version will be posted at http://www.epa.gov/qa/guidelines/g11_guidelines.html upon completion.
- Q **Method Development Project** - pertains to situations where there is no existing standard method, or a standard method needs to be significantly modified for a specific application. Additional guidance is given in "QAPP Requirements for Method Development Projects".
- Q **Model Development Project** - includes all types of mathematical models including static, dynamic, deterministic, stochastic, mechanistic, empirical, etc. Additional guidance is given in "Guidance for Quality Assurance Project Plans for Modeling" G-5M, December, 2002.
- Q **Sampling and Analysis Project** - pertains to the collection and analysis of samples with no objectives other than to provide characterization or monitoring information. Additional guidance is given in "QAPP Requirements for Sampling and Analysis Projects".
- Q **Secondary Data Project** - pertains to environmental data collected from other sources, by or for EPA, that are used for purposes other than those originally intended. Sources may include: literature, industry surveys, compilations from computerized databases and information systems, and computerized or mathematical models of environmental processes. Additional guidance is given in "QAPP Requirements for Secondary Data Projects" which corresponds to Chapter 3 of R-5.

QAPP REQUIREMENTS FOR BASIC RESEARCH PROJECTS

A basic research project is a study performed to generate data used to evaluate unproven theories, processes, or technologies.

SECTION 1.0, PROJECT OBJECTIVES AND ORGANIZATION

- 1.1 State the project objectives.
- 1.2 Identify the responsibilities of all project participants (e.g., QAPP preparation, sample collection and analyses, data reduction/validation/analysis, report preparation, QA).

SECTION 2.0, EXPERIMENTAL APPROACH

- 2.1 Describe the process, site, facility, apparatus, and/or environmental system to be tested.
- 2.2 Describe all known or pre-established test conditions and variables, including replicate experimental runs.
- 2.3 Describe the planned approach (statistical and/or non-statistical) for evaluating project

objectives (i.e., data analysis).

SECTION 3.0, SAMPLING AND MEASUREMENT APPROACH AND PROCEDURES

3.1 Complete a table similar to the following to summarize the experimental sampling strategy to be used.

Sample/Measurement Location	Matrix	Measurement	Frequency	Experimental QC ¹	Total No. Samples

¹QC samples generated during experiment, as applicable (e.g., blanks, replicate samples, spikes)

3.2 Complete a table similar to the following to summarize the experimental sampling and analytical procedures to be used.

Matrix	Measurement	Sampling/ Measurement Method ¹	Analysis Method ¹	Sample Container/ Quantity of Sample	Preservation/ Storage	Holding Time(s) ²

¹Provide details in text, as necessary, if standard method or SOP cannot be referenced

²Both to extraction and analysis, if applicable

SECTION 4.0, QA/QC CHECKS

Complete a table similar to the following to summarize QA/QC checks.

Matrix	Measurement	QA/QC Check ¹	Frequency	Acceptance Criteria	Corrective Action

¹Include all QA/QC checks (experimental and analytical, as applicable) for accuracy, precision, detection limits, mass balance, etc. (e.g., matrix spikes, lab control samples, blanks, replicates, surrogates)

SECTION 5.0, DATA REPORTING

Describe data reduction procedures specific to the project.

SECTION 6.0, REFERENCES

Provide references to methods and germane prior publications.

IN ADDITION, WHEN APPLICABLE...

- § If bulk sample(s) will be collected in the field for use in laboratory experiments, include applicable information from Section 2.0 of *QAPP Requirements for Sampling and Analysis Projects*.

- § List all project-specific target analytes (i.e., when a class of compounds is specified in the table).
- § Indicate if reporting is on a wet or dry weight basis (solid matrices only).
- § Describe the method used to establish steady-state conditions.
- § Describe how sampling equipment is calibrated.
- § Describe how cross-contamination between samples is avoided.
- § Describe the procedures used to collect representative samples.
- § Describe sample packing and shipping procedures.
- § Describe instrument calibration procedures and acceptance criteria if not included in a referenced method or SOP.

QAPP REQUIREMENTS FOR SAMPLING AND ANALYSIS PROJECTS

A sampling and analysis activity or project is typically defined as a study performed to generate data to either monitor parameters on a routine basis or to characterize a particular population for later studies. The following requirements should be addressed as applicable.

SECTION 1.0, PROJECT DESCRIPTION AND ORGANIZATION

- 1.1 The purpose of the study shall be clearly stated in the sampling and analysis plan (SAP).
- 1.2 Responsibilities and points of contact for each organization shall be identified in the SAP. This should include identification of key personnel and/or organization(s) responsible for sample collection and custody, analytical and/or process measurements, data reduction, report preparation, and quality assurance.

SECTION 2.0, SAMPLING

- 2.1 Sampling points for all measurements (*i.e.*, analytical, physical, and process, including locations and access points) shall be identified in the SAP whenever possible. If the specific locations cannot be identified at the time of plan generation, discuss the documentation and/or communication mechanism(s) for ensuring adequate information is captured to later identify sampling points.
- 2.2 The anticipated sampling frequency (*e.g.*, how many sampling events and how often events occur), the number of sample types (*e.g.*, metals, VOCs, SVOCs, *etc.*), and the minimum number of samples of each type taken at each event shall be provided.
- 2.3 The expected measurements (*i.e.*, specific analytes) planned for each sample type shall be summarized.
- 2.4 If applicable, known site-specific factors that may affect sampling procedures shall be described.
- 2.5 If applicable, any site preparation (*e.g.*, sampling device installation, sampling port modifications) needed prior to sampling shall be described.
- 2.6 Each sampling procedure (including a list of equipment needed and the calibration of this

equipment as appropriate) to be used shall be discussed or referenced. Maintenance requirements/procedures (as appropriate) must also be addressed in this section.

- 2.7 If compositing or splitting of samples is planned, the applicable procedures shall be described.
- 2.8 A list of sample quantities to be collected, and the sample amount required for each analysis, including QC sample analysis, shall be specified.
- 2.9 Containers used for sample collection, transport, and storage for each sample type shall be described.
- 2.10 Sample preservation methods (*e.g.*, refrigeration, acidification, *etc.*) shall be described.
- 2.11 Requirements for shipping samples shall be described.
- 2.12 Holding times requirements shall be noted.
- 2.13 Procedures for tracking samples in the laboratory and for maintaining chain-of-custody when samples are shipped shall be described. COC procedures shall be described to ensure that sample integrity is maintained (labeling, seals, records).
- 2.14 Information to be recorded and maintained by field personnel shall be discussed.

SECTION 3.0, TESTING AND MEASUREMENT PROTOCOLS

- 3.1 Each analytical method to be used shall be referenced. This includes EPA-approved and other validated nonstandard methods.
- 3.2 If applicable, modifications to EPA-approved or other validated nonstandard methods shall also be described.

SECTION 4.0, QA/QC CHECKS

- 4.1 The SAP shall list and define all calibrations and QC checks and/or procedures used for the project, both field and laboratory as needed.
- 4.2 For each specified calibration, QC check, or procedure, required frequencies and acceptance criteria shall be included.

SECTION 5.0, DATA REDUCTION AND REPORTING

- 5.1 Data reduction procedures specific to the project, and also specific to each organization, shall be summarized.
- 5.2 The reporting requirements (*e.g.*, units, reporting method [*e.g.*, wet or dry]) for each measurement and matrix shall be identified.

SECTION 6.0, REPORTING REQUIREMENTS

The deliverables expected from each organization responsible for field and/or analytical activities shall be described.